Structure of CBCS M. Sc. (Physics) Course

Course Outcomes:

Course No.	Name of Paper	Course Outcomes(CO)
1st Semester		
PHY/1/CC/01	Mathematical Methods	The students will have understanding of: 1. Basic and advanced mathematical tools required for Physics Problems 2. Different Techniques to solve differential and integral equations 3. Various special functions and important transforms and their applications
PHY/1/CC/02	Classical Mechanics	The students will have understanding of : 1. Idea and concepts in classical physics 2. Basic concepts in Variational principle and Principle of Least Actions 3. Derivations, neccessity and applications of Lagrangian and Hamiltonian formulations 4. Central force problems, theory of small oscillations and and its applications
PHY/1/CC/03	Electronics and Instrumentation	The students will have understanding of: 1. Characteristics and applications of P-N junction diodes 2. Characteristics of different transistors, and different biasing operations, and their applications 3. Operational Amplifier characteristics, its applications. 4. Different types of transducers, impedence matching, filtering and noice reduction techniques, etc.
PHY/1/FC/04(a-c)	PHY/1/FC/04(a) Environmental Physics	The students will have understanding of: 1. Importance, structure a thermodynamics of our environment 2. Sensitization/awareness on Glo warming and its causes 3. Different sources of environme pollution
	PHY/1/FC/04(b) Basic Mathematical Physics	This course is designed as revision to basic Mathematics learnt at UG level so that students can easily adapt to the advanced Mathematics and Physics being taught in the PG level.

	PHY/1/FC/04(c) Experimental Error Analysis	The students will have understanding of 1. Types and Sources of errors, importance of evaluating the errors, and how to write results and errors in a proper manner by utilizing significant figures. 2. How to propagate errors, and how to check the quality of the result and different techniques used.
PHY/1/CC/05	Lab-I (A&B) - Core Lab	The students will have practical understanding of the characteristics of various diodes, transistors, Op-Amp, designing concepts of logic gates and digital circuits. They will also be trained in basic elements and measurement using multimeters and utilization of CRO.
2nd Semester		
PHY/2/CC/06	Quantum Mechanics-I	The students will have understanding of 1. Difference between classical and quantum mechanical theory and approach 2. Linear Vector Space, operators and tools to calculate eigen values 3. Various techniques to solve time dependent and time independent Schrodinger equations using different coordinate systems 4. Connection between symmetry and conservation laws, commutation relations, tools to calculate components and total angular momentum. 5. Various approximation methods utilized in Quantum Mechanics
PHY/2/CC/07	Condensed Matter Physics	The students will have understanding of 1. Structures of solids and their characterization using X-ray techniques 2. Concepts of energy bands and their origin, 3. Electrical, thermal, magnetic, dielectric and optical properties of solids 4. Basic ideas in superconductivity.
PHY/2/CC/08	Computational Technique	The students will have understanding of 1. Fortran programming 2. Concepts on formatting, rounding off rules and errors 3. Different numerical techniques utilized in programming.
PHY/2/FC/09(a-d)	PHY/2/FC/09(a) Photonics	The students will understand basic ideas in Photonics, nature of light, energy bands in solids, absorption and emission spectra, luminescence and types, basic working principle and characteristics of light detectors.

	PHY/2/FC/09(b) Optoelectronics	The students will gain knowledge in the concepts and working principle of optical fibres, modulation and polarization techniques, working principles of semiconductor lasers, photo detectors, amplification using PMT.
	PHY/2/FC/09(c) Electromagnetism	This course is revision to electromagnetic theory studied in UG and they will be trained to solve static problems in electromagnetic theory so that students will have no difficulty when they are taught electrodynamics in the 3rd semester.
	PHY/2/FC/09(d) Disaster Management	The course is intended to sensitize students to different types of disasters and how to deal with each type. The course is also aimed at giving awareness to students the Do's and Don'ts during disaster.
PHY/2/CC/10	Lab-II (Core Lab)	The students will gain practical knowledge in utilizing different types of Interferometers for various uses, practical handling of Lasers and their applications, study of GM characteristics etc.
PHY/2/CC/11	Lab-III (Computer Lab)	The students will be able to write their own Fortran program, compile and execute. They will also be exposed to practical implementation of numerical methods in programming.
PHY/2/OE/12(a-d)	PHY/2/OE/12(a) Fundamentals of Material Science	The students will understand different types of bonds in solids, differences between insulators, semi-conductors and conductors based on energy gaps, and biasing effects in p-n junctions.
	PHY/2/OE/12(b) Electronic Devices	The students will gain basic knowledge in the working principles of CRO, PMT and photo detectors. They will also understand the working principles of vacuum tubes, microphones etc.
	PHY/2/OE/12(c) Basic Astronomy	The students will understand- Composition of solar system, types of planets, difference between asteroids, comets and meteors, Meaning of celestial sphere, constellations and nomenclature of stars.
	PHY/2/OE/12(d) Introduction to Nanotechnology	The students will understand 1. Background, emergence and challenges in nanoscience, types of materials based on their degrees of freedom. 2. Different types of preparation of nanomaterials, characterization techniques and their interpretations.
3rd Semester		

PHY/3/CC/13	Quantum Mechanics II	Students will have understanding of: 1. Scattering theory and validity of Bonn approximations, partial wave analysis 2. Importance of relativistic quantum mechanics compared to non-relativistic quantum mechanics. 3. Various tools to understand field quantization and related concepts. 4. Exposure to quantum field theory and universal interactions.
PHY/3/CC/14	Atomic & Molecular Physics	The students will understand: 1. Fine structure of hydrogen, effects of spin-orbit interaction, atomic spectra 2. Effects of magnetic field in the atomic spectra, principle of ESR and NMR 3. Rotational, vibrational, electronic and Raman Spectra of molecules 4. Basic working Principle of Laser
PHY/3/CC/15	Electrodynamics	The students will understand 1. The difference between static and dynamical systems 2. Maxwell's equations and time-varying fields 3. Gauges in electrodynamics, retarded potentials and its applications 4. Radiation from time varying source, charged particle dynamics and relativistic electrodynamics
PHY/3/SC/16(a-d)	PHY/2/SC/16(a) Advanced Condensed Matter Physics I	The students will understand free electron bands in solids, imperfections in crystals, propagation of electromagnetic waves in solid.
	PHY/2/SC/16(b) Advanced Electronics I	Students are expected to learn AM, FM and Fiber-Optic Modulation Techniques utilized in electronic and Fiber-optic communication systems.
	PHY/2/SC/16(c) Laser and Spectroscopy I	The student will learn the condition of laser oscillation in different types of optical resonators, their stability, techniques of laser pulse generation, and different kinds of laser systems.
	PHY/2/SC/16(d) Computational Physics I	Students will learn the basics of Computational Physics and numerical methods, its application by using Matrix calculations to solve problems, Fourier series and related problems
PHY/3/SC/17(a-d)	PHY/3/SC/17(a) Advanced Condensed Matter Physics II	Students will understand the 1. Green's function and relation to Kramers Kronig relation to fund optical response in solids. 2. Quantum theory of absorption, dispersion etc and 3. Theory of dielectric polarisation and applications.

	PHY/3/SC/17(b) Advanced Electronics II	Students are expected to learn about propagation and properties of radio waves including terrestrial properties, basics of Antenna & their types.
	PHY/3/SC/17(c) Laser and Spectroscopy II	Students will understand the characteristics of different lasers. Applications of lasers in different area like optical communication, three-dimensional recording laser induced fusion and communication in submarine.
	PHY/3/SC/17(d) Computational Physics II	Students will learn the ideas of ODE and Partial Differential Equations(PDEs) and their applications, Boundary value problems and its application to quantum mechanical problems
PHY/3/CC/18	Lab– IV(Core Lab)	Students are expected to perform & determine the values by using Fabry-Perot interferometer, Ultrasonic diffractometer, GM Counter, Planck's constant and Stefan's constant apparatus, Babinet compensator and solid state laser
PHY/3/SC/19	Lab– V (Specialization Course Lab)	
	Advanced Condensed Matter Physics	Students will understand how to find Bolstzman constant, dielectric constant, Plank's constant, Stefan's constant etc. These are related very much to study several physical properties.
	Advanced Electronics Course Outcomes	Students are expected to perform & learn through real-time data by using Practical set ups such as Operational Amplifiers, Power Supply, Converters, IC timer 555, Diac/Triac, Fiber optic communication & transistor biasing.
	Laser and Spectroscopy	Student will have practical experience in observing some of the important physical phenomena in physics such as quantization of charge and electron energy; nature of emission spectrum of hydrogen, sodium and mercury; and physical properties of laser beam.
	Computational Physics	Students are expected to perform & learn computation of data by using different numerical methods, solving boundary value problem and solving with Fourier transform, solution of ODE and PDE
PHY/3/OE/20(a-c)	PHY/3/OE/20(a) Radiation Physics	The students will understand different sources of radiations, their classification, and their interaction with matter. They will also understand the theory of radioactivity. They will also understand radiation detection and measurement techniques, their practical use in medical sciences, archeology, and issues related to radioactive waste disposal.

	PHY/3/OE/20(b) Basics of Atmospheric Sciences	The students will understand the composition of our atmosphere, and laws that govern the thermodynamics of our atmosphere. They will also understand the basic dynamics of the atmosphere and polluting agents. They will also understand basic theory in meteorology.
	PHY/3/OE/20(c) Communication Systems	The students will understand basic theory behing electronic communication and different types of satellites. They will also understand the concepts in mobile communication.
4th Semester		
PHY/4/CC/21	Statistical Physics	The students will understand different types of ensembles, relation between statistics and thermodynamics, quantum statistics and other related phenomena
PHY/4/CC/22	Nuclear and Particle Physics	The students will understand 1. Basic properties of nucleus, its structure and different models that explain the behavior and characteristics. 2. Bound state of deuteron by scattering theory 3. Types of nuclear reactions and conservation laws, reaction mechanisms 4. Basic particle physics, conservation laws C, P, T invariance and relativistic kinematics
PHY/4/SC/23(a-d)	PHY/4/SC/23(a) Advanced Condensed Matter Physics III	The students will understand Fermi surface and effect of temperature, Meaning of cyclotron resonance, Hund's rule and quantum theory of diamagnetism, Heisenberg interaction energy and dispersion relation.
	PHY/4/SC/23(b) Advanced Electronics III	Students are expected to learn about Integrated Circuits (ICs), Radar communication and Satellite communication systems.
	PHY/4/SC/23(c) Laser and Spectroscopy III	The student will learn determination of molecular structure from its vibrational spectra; instrumentation in optical spectroscopy, sources of noise and their minimization, techniques of IR and Raman spectroscopies, and interpretation of the spectra.
	PHY/4/SC/23(d) Computational Physics III	Students will learn the Gaussian functions and their applications to Quantum scattering, learning software like LaTex, Mathematica, Crystal and Gaussian
PHY/4/SC/24(a-d)	PHY/4/SC/24(a) Advanced Condensed Matter Physics IV	The course exposes the students to topics on material science using density functional theory. An energy band is made clear from TBA and KKR methods. Details of superconductivity are discussed and students are made aware of SQUID and Quantum Hall effect with their applications, introduction to Surface Physics and related phenomena.

	PHY/4/SC/24(b) Advanced Electronics IV Course Outcomes	Students are expected to learn about Transmission and Reception of TV signals, working of microprocessor and types of signal noise & its analysis.
	PHY/4/SC/24(c) Laser and Spectroscopy IV	Students will learn the modern trends of spectroscopy using lasers as a source of excitation. Laser induced florescence and their characterization. High resolution spectroscopy, saturation and two and multi photon spectroscopy LIBS and Non-linear Raman spectroscopy.
	PHY/4/SC/24(d) Computational Physics IV	Students will learn the simulation methods like Monte Carlo method and Molecular Dynamics, introduction to Parallel computing and Quantum computing
PHY/4/SC/25	Lab– VI (Specialization Course Lab)	
	Advanced Condensed Matter Physics	The students will learn Hall effect in semiconductor, learn photoconductivity of CdS material, measurement of magnetic susceptibility of solids and Lande's g factor, learn the method to calculate DOS using WIEN2k code.
	Advanced Electronics	Students are expected to perform & learn through real-time data by using Practical set ups such as Amplifiers, Flip Flops, Multiplexers, Microwave Trainer, VLSI Trainer & SCR.
	Laser and Spectroscopy	Through this course the students will have practical experience in handling some spectroscopic instruments such as CDS, Monochromator, FT spectrometer; observed the phenomenon fluorescence; will perform vibrational analysis and study optical characteristics of fibre optics.
	Computational Physics	Students are expected to perform & learn handling of LaTex, solution of Quantum mechanical problems, computation of data by using Crystal and Gaussian software, learning algorithm and simulation of data by using Monte Carlo and Molecular Dynamics
PHY/4/CC/26	Project Work	The student will gain experience in research. They will understand the research methodology and will help them in their future research career.

CC= Core Course, FC = Foundation Course, SC =Specialization Course, OE=Open Elective

Program Outcomes: At the end of the program, the student will be able to:

PO1	Have knowledge and experience in different techniques of optical spectroscopy including the instrumentations and interpretation of the spectra in IR, Raman, Electronic Absorption and Fluorescence spectroscopy.
PO2	learn various techniques of radio wave propagation, antenna, ICs and various types of communication systems including Television broadcasting & noise analysis
PO3	learn advanced condensed matter physics and material sciences
PO4	Learn advanced computing methods required for basic sciences as well as industrial

	applications
PO5	Have advanced ideas and techniques required in frontier areas of Physics, and develop human resource with specialization in theoretical and experimental techniques required for career in academia and industry.
PO6	Pursue research career in any branch of physics

Program Specific Outcomes: At the end of the program, the student will be able to:

PSO1	Understand and apply basic principles of physics, and basic interaction laws that govern our universe
PSO2	Understand and apply mathematical tools required for describing and understanding the physical systems
PSO3	Understand the basic differences in classical and quantum mechanical approach, their realm and applicability in a certain domain
PSO4	Understand and apply statistical methods in solving real physical problems, and its application and connection with thermo dynamical laws
PSO5	Understand the nature of a nucleus, nuclear reaction mechanism, nuclear models and its usefulness in power generation and for medical sciences.
PSO6	Understand and acquire basic knowledge in various techniques in optical spectroscopy and interpretation of spectra
PSO7	Understand and apply computational techniques and apply to real physical problems

Course No.	**Course Title**	**Course Credit**	**Marks Scale**			**Credit distribution**			**Exam (hrs)**	
1st Sem.			**C/A**	**Ext**	**Total**	**L**	**T**	**P**	**T**	**P**
PHY/1/CC/01	Mathematical Methods	**4**	40	60	100	3	1	0	3	-
PHY/1/CC/02	Classical Mechanics	**4**	40	60	100	3	1	0	3	-
PHY/1/CC/03	Electronics and Instrumentation	**4**	40	60	100	3	1	0	3	-
	Foundation Course (*any two*)									
PHY/1/FC/04(a)	Environmental Physics	**2**	40	60	100	1	1	0	2	-
PHY/1/FC/04(b)	Basic Mathematical Physics	**2**	40	60	100	2	0	0	2	-
PHY/1/FC/04(c)	Experimental Error Analysis									
PHY/1/CC/05	Lab - I (A&B) - Core Lab	**6**	40	100	100	0	0	6	-	6
2nd Sem.	**Total**	**22**			**600**	**12**	**4**	**6**		
PHY/2/CC/06	Quantum Mechanics I	**4**	40	60	100	3	1	0	3	-
PHY/2/CC/07	Condensed Matter Physics	**3**	40	60	100	2	1	0	3	-
PHY/2/CC/08	Computational Technique	**3**	40	60	100	2	1	0	3	-
	Foundation Course(*any two*)									
PHY/2/FC/09(a)	Photonics	**2**	40	60	100	1	1	0	2	-
PHY/2/FC/09(b)	Optoelectronic Devices	**2**	40	60	100	2	0	0	2	-
PHY/2/FC/09(c)	Electromagnetism									
PHY/2/FC/09(d)	Disaster Management									
PHY/2/CC/10	Lab -II (Core Lab)	**3**	40	60	100	0	0	3	-	3
PHY/2/CC/11	Lab –III (Computer Lab)	**3**	40	60	100	0	0	3	-	3
	Open Elective I *(any one)*									
PHY/2/OE/12(a)	Fundamentals of Material Science	**2**	40	60	100	2	0	0	3	-
PHY/2/OE/12(b)	Electronic Devices									
PHY/2/OE/12(c)	Basic Astronomy									
3rd Sem.	**Total**	**22**			**800**	**12**	**4**	**6**		
PHY/3/CC/13	Quantum Mechanics II	**3**	40	60	100	2	1	0	3	-
PHY/3/CC/14	Atomic & Molecular Physics	**3**	40	60	100	2	1	0	3	-
PHY/3/CC/15	Electrodynamics	**3**	40	60	100	2	1	0	3	-

PHY/3/SC/16(a-d)	*Special Paper I* Specialization Course-I	**3**	40	60	100	2	1	0	3	-
PHY/3/SC/17(a-d)	*Special Paper II* Specialization Course-II	**3**	40	60	100	2	1	0	3	-
PHY/3/CC/18	Lab – IV (Core Lab)	**3**	40	60	100	0	0	3	-	3
PHY/3/SC/19	Lab –V (Spl. Course Lab)	**2**	40	60	100	0	0	2	-	3
PHY/3/OE/20(a) PHY/3/OE/20(b) PHY/3/OE/20(c)	**Open Elective II** *(any one)* Radiation Physics Basics of Atmospheric Science Communication Systems	**2**	40	60	100	2	0	0	3	-
4th Sem.	**Total**	**22**			**800**	**12**	**5**	**5**		
PHY/4/CC/21	Statistical Physics	**3**	40	60	100	2	1	0	3	-
PHY/4/CC/22	Nuclear and Particle Physics	**3**	40	60	100	2	1	0	3	-
PHY/3/SC/23(a-d)	*Special Paper III* Specialization Course-III	**3**	40	60	100	2	1	0	3	-
PHY/3/SC/24(a-d)	*Special Paper IV* Specialization Course-IV	**3**	40	60	100	2	1	0	3	-
PHY/4/SC/25	Lab – VI (Spl. Course Lab)	**2**	40	60	100	0	0	2	-	3
PHY/4/CC/26	Project Work	**8**	40	60	100	0	0	8	-	6
	Total	**22**			**600**	**8**	**3**	**11**		
	Grand Total	**88**			**2800**	**61**		**27**		

Note: 1. L = Lecture, T = Tutorial, P = Practical
2. Choice of OE(s) would be available based on the availability of Faculty.
3. CC = 60 Credits, FC = 8, Credits, SC =16 Credits, OE = 4 Credits
4. Theory = **61** Credits, Practical = **27** Credits